Fermilab

Technical Scope of Work

E-938 (MINERvA)
And
Fermilab

Version 2.0

An experiment to measure
Neutrino-Nucleon cross sections
with the Fermilab Main Injector Neutrino Beam (NuMI)

February 8, 2012

I. INTRODUCTION

This is a Technical Scope of Work (TSW) between the Fermi National Accelerator Laboratory (Fermilab) and the E-938 experimenters to perform E-938 in the Fermilab Main Injector Neutrino Beam (NuMI) line. The TSW is intended primarily for the purpose of recording expectations for budget estimates and work allocations for Fermilab, the funding agencies and the participating institutions. The TSW reflects an arrangement that currently is satisfactory to the parties. However, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to modify this TSW to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents. This TSW fulfills Article 1 (facilities and scope of work) of the User Agreements signed (or still to be signed) by an authorized representative of each institution collaborating on this experiment.

The experiment uses the MINERvA detector, including an upstream nuclear target region, a tracker region, and electromagnetic and hadronic calorimetry. The MINOS Near Detector also plays an integral part of MINERvA because it provides the momentum measurement for muons entering MINOS from MINERvA. The experiment utilizes the existing NuMI Neutrino Beam at Fermilab. The NuMI Beamline consists of a graphite target within a two-horn focusing system followed by a 675 m long decay volume. Downstream of the decay volume is the hadron absorber, followed by a muon monitoring system for tertiary muon measurements. Following the third muon monitoring plane there is approximately 210m of rock shielding and the MINERvA detector.

II. EXPERIMENT COLLABORATION PERSONNEL AND INSTITUTIONS

Co-spokespersons: Kevin McFarland (Rochester) and Deborah Harris (Fermilab)

MINERvA Executive Committee: Ron Ransome (Rutgers), Tony Mann (Tufts), M. Eric Christy (Hampton), Jorge Morfin (Fermilab), Kevin McFarland and Deborah Harris, *ex-officio as Co-Spokespersons*

Analysis Coordinator: Mike Kordosky (William and Mary)

MINERvA Operations Heads (Run Coordinators): David Schmitz (Fermilab) and Cesar Castromonte (CBPF), Howard Budd (Rochester), and Rik Gran (Duluth)

Mechanical Installation Coordinator: Jim Kilmer (Fermilab)

Electrical Installation Coordinator: Linda Bagby (Fermilab)

Accelerator Division (AD) Liaison: Phil Adamson (Fermilab)

Computing Division (CS) Liaison: Rick Snider (Fermilab)

A complete list of Scientific personnel and corresponding level of effort from all institutions can be found in Appendix III of this document. Fermilab Experimenters presently committed to this experiment, with fraction of research time to be dedicated to MINERvA in 2012 indicated:

D. Harris, Scientist, 95%

J. Morfin, Scientist, 75%

R. Snider, Scientist, 50%

J. Osta, Post-doctoral Scientist, 100%

D. Schmitz, Lederman Fellow, 100%

There are currently 21 institutions that are members of MINERvA and the roles and responsibilities are described through an Institutional MOU process whereby each institution provides a list of authors, their current effort level on the experiment, and their areas of service and analysis. A summary of the research fraction per institution and per job type is given in the following table (which is a summary of Appendix I):

	Teaching faculty	Scientist	Postdoc	PhD Student	Master Student	Undergraduate student	Total
Athens	0.3	0	0	0	0	0	0.3
CBPF	0	0.7	1	2	1	0	4.7
Duluth	0.75	0	0	0	1	0	1.75
Fermilab	0	2.2	2	0	0	0	4.2
Guanajuato	0	1.7	0	2	1	3.1	7.8
Hampton	1.15	0.2	0.85	1	0	0	3.2
INR	0	0.5	0	0	0	0	0.5
JMU	0.5	0	0	0	0	0	0.5
MCLA	1	0	0	0	0	0	1
Northwestern	0.5	0	0.7	0	0	0	1.2
Otterbein	0.7	0	0	0	0	0.8	1.5
Pittsburgh	1.4	0	0.33	1	0	0	2.73
PUCP	0.4	0	0	0	2	0	2.4
Rochester	1.4	0.9	2.7	4.5	0	0	9.5
Rutgers	0.9	0.1	0.9	1	0	0	2.9
Texas -Austin	0.8	0	1	1	0	0	2.8
Tufts	1.5	0.5	0	0	0	2	4
UC Irvine	0	0	0	2	0	0	2
UF	0.9	0	0.8	1.3	0	0	3
UNI	1.4	0	0	1	1	0	3.4

USM	0.76	0.33	0.65	0.6	0	0.6	2.94
W&M	1.42	0	0.5	2.9	0	0	4.82
Total	**15.78**	**7.38**	**11.43**	**20.3**	**6**	**6.5**	**67.39**

The experimental operations are also described through the MOU process, and the major categories are currently the shared responsibilities of the following institutions:

Detector Calibration Database: Pittsburgh, Rochester, MCLA, USM

Experimental Operations: FERMILAB, CBPF, Rochester, Northwestern, Rutgers

Cryogenic Target: Hampton, Fermilab, Rochester, Rutgers

Water Target: Rochester, Fermilab

Electronics Calibration and Maintenance: Rochester, Pittsburgh, Fermilab

Data Acquisition System: Rochester, CBPF

Test Beam: Duluth, Fermilab, UNI, PUCP

Module Transport: Fermilab, Rochester

III. EXPERIMENTAL AREA, BEAMS

Location

The experiment will take place in the NuMI beamline, and the NuMI Near Detector Hall. For details of the civil construction of the detector hall, see the NuMI Conceptual Design Report and NuMI/MINOS Project Execution Plan. The MINERvA detector design is also predicated on the fact that the MINERvA detector will sit directly in front of the MINOS Near Detector. Most physics results of the MINERvA experiment require that the MINOS Near Detector be operational. The MINOS Near Detector and its performance are described in Reference (D.G. Michael et al, *Nucl. Instrum. Meth.* A596:190-228,2008).

Beam and Intensity

The NuMI beamline uses the 120 GeV proton beam from the Main Injector. The experiment expects beam performance similar to what MINOS has seen in the recent performance of the beamline: approximately 3.5 x 10^{13} POT per beam spill, at up to 0.45 Hz

MINERvA's physics capabilities for the low-energy target configuration are based on a total of number of 4×10^{20} POT. The Low Energy horn configuration is where the horns are separated by 9m, and with the horns are set to focus positive mesons, resulting in a neutrino beam.

MINERvA will additionally require 0.9×10^{20} POT in the Low Energy neutrino beam configuration to be used for a set of special runs where either the target position with respect to the first horn will be altered from the nominal position, or where the horn current will be reduced or even set to zero.

A test beam run in MTEST on a smaller prototype of the detector (T-977) is an important part of the MINERvA program and is described in the test beam MOU (http://minerva-doCSb.fnal.gov:8080/cgi-bin/ShowDocument?docid=1196).

MINOS Near Detector Operations

The MINOS Near Detector provides the muon momentum and charge measurement for those muons that exit from the MINERvA detector and traverse a minimum distance within the MINOS detector. For that reason the MINOS Near Detector must be operating and the resulting muon information made available to the MINERvA collaboration. Operation of the MINOS Near Detector will be a shared responsibility of the MINERvA and MINOS experimenters. MINOS will provide training and documentation for running their Near Detector. Currently there are personnel from both the Computing Sector and the Particle Physics Division who are assisting with the MINOS Near Detector operations, this level of Near Detector support will need to be maintained while MINERvA is operational.

Detector Hall Environment

For the duration of the MINERvA experiment the space directly between the MINERvA detector and the MINOS Near Detector must always be kept clear in order to ensure the accuracy of the momentum measurement of particles exiting MINERvA and entering MINOS. This includes both equipment and personnel. Even temporary use of this space will represent a period of reduced data taking efficiency for MINERvA and should be coordinated well in advance with the MINERvA operations group.

For the duration of the MINERvA experiment the ceiling above the detector must remain in good repair so that groundwater does not drip on the detector. This includes (but is not limited to) regular maintenance of the drip pans that are above the detector, and repair of any cracks in the sealing material that was applied prior to the start of the MINERvA detector installation.

In the event of any additional excavation underground the MINERvA and MINOS detector electronics must be kept clear of dust and other debris. For the case of MINERvA this may require a secondary containment structure that encloses the detector itself as well as the associated electronics racks. This structure must be kept under positive air pressure and adequate ventilation in order for the MINERvA detector to remain on for a substantial fraction of any long shutdown when this excavation would take place.

Furthermore, in the event of any additional work underground, the MINERvA and MINOS detectors, and the MINOS coil must not be turned off for more than 3 weeks, and the underground cooling and dehumidification must be operated continuously, with at most a few days disruption to either of those services.

In order to maintain flexibility to reconfigure the nuclear target region of the MINERvA detector, the auxiliary stand that is currently to the south and east of the MINERvA detector must remain in its current location for the duration of the MINERvA experiment. The stand must also remain accessible for use. To maintain that same flexibility, the access passageway between the MINOS shaft and the Near Hall must also remain sufficiently clear, with the exception of the time when there is additional excavation underground.

During the entire operations phase of MINERvA, the experimenters expect to be able to access the detector hall and to transport small items such as small computers on a regular basis. Larger items that require the crane shaft, Ingrid's Cart, and the Near Detector Hall crane will also need to be transported occasionally. Interruptions in access should be planned in advance and coordinated with the MINERvA operations group.

IV. FERMILAB INSTITUTIONAL RESPONSIBILITIES

A. Accelerator Division (AD)

Personnel:

Liaison Physicist: Phil Adamson (TBC)

The Accelerator Division will be responsible for commissioning, operation and maintenance of the primary proton beam line, the target station and the hadron absorber. The line of demarcation between Accelerator Division and Particle Physics Division responsibilities is, unless otherwise noted, the large doors just upstream of the MINOS shaft.

AD will also be responsible for monitoring intensity and beam quality of the primary proton beam. Overall monitoring of the primary proton beam intensity within 3% is required by the experiment.

The Accelerator Division has upgraded the integrated proton intensity to NuMI to a rate approaching the capability of 3.3×10^{20} protons/year by increasing the proton intensity/pulse and decreasing the Main Injector cycle time. Fermilab welcomes and encourages collaboration between MINERvA non-Fermilab institutions and Accelerator Division in the planning and execution of proton intensity upgrade projects.

The MINERvA Experiment depends on support from a number of departments within AD. The AD provides a liaison to the MINERvA experiment. The deliverables and services expected from each of these groups are described below.

1. External Beams Department

The External Beams Department is the proprietor of the NuMI beamline from the Main Injector to the hadron absorber. The Department also controls access to the muon alcoves. The Department provides a Machine Coordinator who is in charge of beamline operations and serves as the point of contact for MINERvA questions involving the beam. The Machine Coordinator's responsibilities concern both operational status and requests from MINERvA for changes in the beamline, target station or hadron absorber. The department also provides a Beamline Physicist who aids in day-to-day operational issues and assists the Machine Coordinator as required.

The External Beams Department contains personnel expert in various elements of the design, operation, and troubleshooting of any beamline, and are called upon by the Machine Coordinator as needed. In addition, budgeting and purchasing of spare equipment and changes to equipment in the NuMI target hall is coordinated by this Department.

2. Controls Department

The Controls Department is responsible for the front-end computers, links, crates and control cards for the operation of all equipment from the Main Injector to the hadron absorber. These responsibilities include the hardware and software of the Beam Permit System. The Department maintains several pieces of application software for controlling beamlines, specific instances of which are used by NuMI. It is responsible for the maintenance of the accelerator consoles in the MINERvA Control Room and NuMI service buildings. It installed and maintains several Programmable Logic Controllers dealing with target-chase cooling and various water systems including beamline LCW, target hall and absorber RAW systems, and near detector cooling. The computer networking in the NuMI underground and above ground installations is also the responsibility of the Controls Department. This Department is responsible for the hardware and software of FIRUS.

3. EE Support Department

The Electrical Engineering Support Department is responsible for all of the power supplies needed to run the magnets of the primary beamline. It is responsible for the NuMI extraction kicker and its power supply, the large pulsed power supply of the NuMI focusing horns, and the electronic control of beamline vacuum.

4. ES&H Department

The AD ES&H Department shall have ES&H oversight responsibility for the AD areas of the NuMI facility as defined in [2]. In addition, the ES&H Department coordinates underground safety training for all NuMI/MINOS areas.

The Department oversees access control to the pre-target beamline enclosure, target hall, decay pipe region, absorber hall, and muon alcoves. Oversight is also provided for radiation and electrical safety in the region of the primary proton beam through various access control keys, enclosure interlocks, electrical permits to power supplies, interlocked radiation detectors, and beam inhibit critical devices.

After discussions between AD/ES&H and PPD/ES&H the following responsibilities have been assigned to the AD ESH Department:

a) Radiological shielding assessment of experimental areas;
b) Radiological surveys;
c) Oversight for handling of LCW/RAW systems;
d) Radiation and electrical-interlock-system-related matters;
e) Participation in exposure investigations as necessary;
f) Monitoring and control of underground access at MI-65 (by controlling keys for the elevator and/or radiation areas for MI-65).
g) Monitoring and control of underground access at MINOS interlocked areas (by controlling keys for the elevator and/or hadron absorber area and muon alcoves). Access to the MINOS and MINERvA detector area is controlled by PPD.

5. Instrumentation Department

The Instrumentation Department is responsible for the maintenance and calibration of primary-beamline monitoring devices – loss monitors, total loss monitors, BPMs, and toroids. The Department will similarly be responsible for operation of the Optical Transition Radiation (OTR) detector. The University of Texas (Austin) was responsible for the development of segmented-foil emission monitors (SEMs), the hadron monitor, and the muon monitors. UT-Austin is proceeding with a separate MOU with the Accelerator Division to cover the responsibilities for these detectors. The Instrumentation Department will be a signatory to that MOU.

6. Main Injector Department

The Main Injector Department is responsible for providing beam with appropriate parameters on NuMI timeline cycles. Such parameters include, but are not limited to, intensity, emittance, and orbit stability. Often insufficient intensity results from conditions in the Booster, and the Booster Department must also become involved in supplying proper beam to the Main Injector.

7. Mechanical Support Department

The Mechanical Support Department is responsible for operational support and maintenance, including magnet changes, of all the mechanical equipment in the Accelerator Division controlled areas. This includes vacuum and water systems throughout the beamline, as well as the decay pipe region and the hadron absorber. The Department has responsibility for technical support of equipment in the target hall and associated areas, including horns, targets, RAW systems, target pile cooling and dehumidification.

8. Operations Department

The AD, via the Operations Department, is responsible for accelerating and extracting 120 GeV primary protons into the NuMI Primary Proton beamline and for maintaining the beam parameters throughout the line and onto the NuMI target. The primary beamline is controlled from the AD Main Control Room.

The Operations Department is responsible for the administration of accesses to MI65 areas, the Muon Alcoves and the Absorber, and for resecuring these areas after a Supervised Access. AD provides first response to alarms in these areas.

Institution	System	Description of Work
Fermilab	Controls hardware	All of the links, crates, etc for operation of the beamline. The computer network in the NuMI areas and appropriate interconnect hardware.
	Primary beam magnets	Spares for all types of magnets have been readied. The ones difficult to transport have been staged in the beamline area.
	Power supplies	Some spare supplies exist, and spare parts for all supplies are available.
	Vacuum equipment	Ion pump failures are addressed either by repairing or by replacing faulty devices.
	Target pile components	There is a spare target and target carrier. There is also a spare set of horns. There is a work cell that an irradiated target or horn module can be placed in for observation and possible repair.
	Instrumentation	Spares are available for most types of beamline instrumentation. For a few types, repair is the only alternative.

Table 4.1.a Fermilab AD Hardware Responsibilities for MINERvA

Institution	System Responsibility	Description of Work
Fermilab	ACNET console software	Copies of standard beamline programs: parameter page, BPM/BLM, profile monitors, vacuum, beam permit.
	Microprocessor software	BPMs, profile monitors.

Table 4.1.b Fermilab AD Software Responsibilties

B. Computing Sector (CS)

See Appendix I for the complete MINERvA MOU with the computing division; an executive summary is provided here.

<u>Personnel:</u>

Fermilab CS Liaison………………………………….................... Rick Snider (Fermilab)

MINERvA Computing Infrastructure Coordinator ……. Heidi Schellman (Northwestern)

MINERvA Offline Software Coordinator ………………..…David Schmitz (Fermilab)

MINERvA Online Software and Data Acquisition ………….. Gabriel Perdue (Rochester)

I. Control Room Operations

There are three distinct sets of computers in the MINERvA data acquisition and monitoring scheme:

A. Control Room PC's in WH12NW
B. Near-Online ("Nearline") machines located in the Feynman Computing Center
C. DAQ PC's located underground in the MINOS Near Detector Hall

High speed networks interconnect these computers and allow the movement of data from the detector to a tape data archive, and transmission of command and monitoring data between the control room and the Detector Hall. All components of this system will be configured and maintained to allow data-taking on a 24x7 basis.

The CS will provide OS support for the Control Room and Nearline computers, and maintain the network infrastructure. Of these, the most critical component is the networking. While MINERvA is designed to function autonomously underground without input from operators in the Control Room for periods of several days with no loss of usable data or data-taking capability, network communications is a vital function. There is sufficient redundancy built into the DAQ system that 8x7 support of these network connections will meet the 24x7 operational needs of the experiment.

A set of "hot" spares will be maintained for the Control Room and Nearline computers. Moreover, data-taking is unaffected by the loss of any of these computers. An 8x5 support policy for these machines will therefore meet the operational needs of the experiment. The details of this support will be documented in specific Service Level Agreement.

The DAQ PC's in the Detector Hall will be supported on a continuous basis by the experiment using a set of spare machines that can be swapped in for ones that fail. The

CS will provide consulting support for OS issues on these machines.

MINERvA is responsible for all application software on the Control Room, Nearline and DAQ PC computers.

II. PREP Electronics

The CS will provide and maintain equipment equipment from the existing PREP electronics stock requested by the experiment required to support test beam operations. Access to PREP will be on an 8x5 basis.

The CS will continue to maintain MINOS Near Detector hardware supported under current agreements that is needed to operate the MINOS Near Detector.

III. DAQ System and Software

The CS will provide system administration support for DAQ and online systems that are visible to networks outside Fermilab. For DAQ systems behind the online firewall, the CS will provide consulting support on an 8x5 basis for issues related to system administration.

MINERvA is responsible for all DAQ application software.

IV. Databases

MINERvA stores its mission critical data relating to the construction of the detector, electronics configuration, and conditions (calibration, alignment, et cetera) in secure databases. It is anticipated that the data size will be a few 10's of GByte per year, and may reach 100GB by the end of the experiment.

The CS will provide hardware and DB administrative support for Oracle databases serving mission-critical data. In addition, the CS will develop and maintain an interface package for the conditions database that meets the operational needs of the experiment. The databases associated with data-taking, such as the configuration and conditions databases, will be supported in such a way as to be robust against network interruptions.

The CS will also support the database associated with the MINERvA data catalog and data-handling system (SAM). An Oracle instance provides the back-end for SAM.

The CS will support an instance of the Control Room Logbook (CRL) product that is used by shift personnel to record information pertinent to detector operations and data quality assurance. As with other Control Room services, operation of the CRL will be maintained on a 24x7 basis.

The MINERvA experiment is responsible for the content of all databases.

V. Disk and Tape Storage

The CS will provide the following disk resources to the GP Grid Farm, the General Physics Computing Facility (GPCF) cluster, and other on-site MINERvA interactive and batch computer via nfs or other agreed upon technologies:

A. A central disk pool storing and serving MINERvA data (raw and reconstructed POOL files, DST's, tertiary datasets, and MC data).

B. MINERvA software release and build areas.

C. Project disk areas needed to support data analysis activities

The target data volume and data rates to be provided for the above disk systems will be discussed and agreed upon by the CS and MINERvA. The CS will make a best effort to meet those targets subject to budget constraints.

The CS will provide a tape data archive accessible via Enstore of sufficient capacity to store all raw detector data (two copies), processed data, and MC data. Procuring the necessary tape capacity will be the highest priority among CS procurements. A front-end disk cache will also be provided as part of the tape archive provisioning. The size and throughput targets for these systems will be chosen to match the computing capacity available for analysis. The CS will also provide tools tools for archiving analysis data.

The CS will provide AFS-mount home disk areas. Regular backups of this space will be performed.

The MINERvA experiment will be responsible for the content of all data storage systems, but will work with CS on file and directory structures to optimize throughput.

VI. Data Analysis and Processing

The CS will provide the following computing systems for data processing and analysis (including MC simulations):

A. An interactive / batch analysis cluster with access to the Central Disk, software release, project, and home areas. The primary purpose of the batch system will be job development and testing.

B. GP Grid Farm resources and the associated grid authentication and authorization services required by the experiment to utilize these resources.

The CS will also provide generic job submission and monitoring tools for the batch resources, and consulting services to offline personnel on issues related to grid utilization.

MINERvA is responsible for writing and submitting all data processing and analysis jobs.

VII. Simulation and Analysis Software Toolkits

The CS will provide an archival cvs, subversion or similar service for MINERvA software. A Redmine web interface and wiki will also be provided as part of this service.

The CS will provide support for physics and utility software packages jointly or singly supported by Fermilab. Such packages include, but are not limited to, root, GEANT4, GENIE, CLHEP and MySQL. The list of supported packages will be specified in joint negotiations.

MINERvA is responsible for the content of the software archive.

VIII. Desktops

MINERvA desktop computers at Fermilab that run the Linux or Windows operating systems are eligible for support by the CS provided that they are maintained in accordance to the general Service Level Agreement for Desktop Computers. At present, no MINERvA desktops receive CS support.

IX. Miscellaneous computing support

The CS will provide the following services and support:

A. An instance of DocDB for use by MINERvA.

B. A central MINERvA web server (system administration and consulting services for web server and application security issues).

C. Off-hours and emergency paging via the Service Desk for selected critical systems. The CS and MINERvA will discuss and agree on the list of systems to receive this level of support. Currently, no systems are on this list.

D. An issue tracking system for MINERvA computing issues. At present, the Fermilab Service Desk is used for issues related to operating system or hardware support, and a MINERvA JIRA service is used for everything else.

X. MINOS Near Detector Requirements

The experiment will need operational support for the following MINOS systems: DAQ networking and computing, MINOS ND PREP maintained hardware, the existing MINOS ND analysis and data processing chain, databases, storage, and analysis CPU. Other areas of operational support may be identified later.

8x5 Support Definition

8x5 support is defined as that covered during a normal work week: 8:30 AM to 5:00 PM, Monday through Friday on normal business weeks of 5 work days. Holidays that fall within the normal work week are not covered. Saturday and Sunday support will fall over to the first work day of the new week.

C.Particle Physics Division (PPD)

Personnel:

ES&H Liaison: Eric McHugh

Infrastructure Requirements:

For the duration of the MINERvA experiment the temperature in the NuMI Near Detector Hall must not be above 75 degrees Farenheit for more than 6 months, integrated over all MINERvA running beginning September 2010, to minimize the aging of the scintillator which reduces the light yield. The average temperature of the hall should vary between 68 and 72 degrees. PPD will also provide a control room that is operational.

Fermilab will provide at least 50% support (exclusive of effort of current Fermilab MINERvA scientists and engineers listed above) for operations of the MINOS Data Acquisition system and near detector operations, as this is an integral part of the MINERvA physics program. Required support for MINOS ND operations will include, but is not limited to, maintenance of MINOS front-end electronics (currently by a subcontract with Argonne), maintenance of the MINOS magnetic coil, support for required maintenance of the MINOS DAQ, backend electronics and crates exclusive of the support provided by Fermilab/CS, and mechanical maintenance of the access platform and MINOS cable plant.

PPD will provide office space for 32 people, as shown below:

Group	**# people full-time**	**# people part-time**
Fermilab Scientists	4	
Resident Visiting Scientists	3	
Fermilab Post-doc	2	
Resident University Post-docs	5	
Resident Students	20	

Shift Personnel	3	
Visiting Collaborators		10
Summer Students		24
TOTALS	**37 people**	**10-24 people**

Total office space request: 47-61 people, including 33 full time desks. It is expected that a number of the 10-24 part-time visitors will occupy space in a generic "Neutrino Department" visitor space. This number of collaborators is what was in place for FY11, and will decrease at roughly the 10% level in the latter half of FY12 and beyond as the experiment matures.

PPD will provide test stand space that is adequate for the following activities: PMT testing and Box repairs, PMT testing, Clear Fiber Cable Quality Assurance testing, a DAQ test stand, and a space that is adequate for storing the hot spare DAQ nodes. In particular, a dark room will be needed for additional PMT testing (before PMT's are put into PMT boxes). The dimensional requirements are discussed in Appendix III of this document.

PPD will maintain the auxiliary stand underground upstream and to the east of the MINERvA full detector stand, in case the nuclear target region needs to be reconfigured to best reach the physics goals of the experiment. Similarly, two short detector stands currently in Wideband (PB7) must also remain in place (or be saved in such a way as to be reinstated in Wideband) until the end of the MINERvA physics run.

PPD will provide storage space for some of the other spare items that have been fabricated for the MINERvA Project: these items include spare scintillator planes, steel wedges, clear fiber cables, and the radioactive source mapper. The storage area needs some temperature control, for spare detector parts (fibers, PMTs, and electronics) as well as space for larger components.

PPD is responsible for maintaining the clean and house power in the underground enclosure and MINERvA needs continuous clean power. Should the MINERvA AC distribution boxes break during the MINERVA run, PPD expertise will be needed (Jamieson Olsen has thus far provided this for MINERvA). The experiment also requires a way to remotely power-cycle Front End Support Boards. This is currently under construction but must be maintained once it is operational. In the event of any reconfiguration of the nuclear target region the experiment will require additional assistance with the electronics installation (the previous electronics installation was coordinated by Linda Bagby).

PPD Is also required for support for Front End Board repairs. There currently is spare stock, but the experiment will want to repair damaged boards, in particular TRIP chips that fail. The experiment also needs support and repairs for the CROC's and the CRIMS and the MINERvA Timing Module. There is a spare stock for all these later items but the spare stock was designed based on the assumption that components that fail would be repaired. Similar needs will arise during the test beam run, but on a smaller scale.

Support Requirements:

PPD will provide resources for occasional technician support for future PMT box repair efforts, as needed. PPD will also provide technicians as needed to support repair work at or near the detector.

PPD will support the Fermilab Scientists in the collaboration for travel and specifically negotiated M&S. This budget will be arranged with PPD at the beginning of each fiscal year.

PPD will provide resources for expert monitoring and maintenance of the cryogenic target, which is filled with liquid Helium. MINERvA shift-takers can also provide frequent checks on the cryogenic target functioning, but will need to be giving contact numbers should any issues arrive with the target.

V. SPECIAL CONSIDERATIONS AND NOTES

5.1 The responsibilities of the Scientific Spokespersons and procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (PFX: http://www.fnal.gov/directorate/documents/pfx.pdf). The Scientific Spokespersons agree to those responsibilities and to follow the described procedures.

5.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. The procedures to carry out these various reviews are found in the Fermilab Particle Physics Division Operating Manual Note PPD_ESH_006: "ES&H Review of Experiments" (http://www-ppd.fnal.gov/DivOffice/Operating_Manual/PPD_ESH_006%20Rev%20of%20Exp.pdf). The spokespersons undertake to follow those procedures in a timely manner.

5.3 The Scientific Spokespersons will ensure that at least one person is monitoring the detector and at least one local person is on-call during an active MINERvA shift. Local on-call shifters will be knowledgeable about the experiment's hazards.

5.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

5.5 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

5.6 MINERvA will keep the Fermilab Office of Program Planning apprised of its progress (operation, and data analysis) on a regular basis and as requested.

5.7 The experiment spokespersons will undertake to ensure that no PREP or Fermilab-supplied computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. They also undertake to ensure that no modifications of PREP equipment take place without the knowledge and written consent of the Computing Division management.

5.8 An experimenter will be available to report on the status and progress of the experiment at Fermilab All Experimenters' Meetings.

5.9 At the completion of the experiment:

5.9.1 The spokespersons are responsible for coordinating the return of all PREP equipment, Computing Division equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the spokesperson will be required to furnish, in writing, an explanation for any non-return.

5.9.2 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied, including computer printout and magnetic tapes. Disposition of magnetic tapes will be in compliance with Fermilab's tape retirement policies. Costs for shipment of printouts and/or tapes will be borne by the receiving university.

SIGNATURES

____________________________ / / 2013 __________________________ / / 2013

Kevin McFarland, MINERvA co-Spokesperson Deborah Harris, MINERvA co-Spokesperon

APPENDIX I. Collaborators and fraction of research effort

The following table is provided by the collaborators as part of the MOU process: The level of effort described below is the fraction of research time for that person: for university teaching faculty the research time is clearly not 100% of an FTE.

Family Name(s)	Given Names(s)	Institution	Job Status	Research Fraction on MINERvA
Bodek	Arie	Rochester	Teaching faculty	10%
Bradford	Robert	Rochester	Postdoc	70%
Budd	Howard	Rochester	Scientist	90%
Chvojka	Jesse	Rochester	PhD Student	100%
Lee	Hyup-Woo	Rochester	PhD Student	50%
Manly	Steve	Rochester	Teaching faculty	50%
McFarland	Kevin	Rochester	Teaching faculty	80%
McGowan	Aaron	Rochester	Postdoc	100%
Mislivec	Aaron	Rochester	PhD Student	100%
Park	Jaewon	Rochester	PhD Student	100%
Perdue	Gabe	Rochester	Postdoc	100%
Wolcott	Jeremy	Rochester	PhD Student	100%
Niculescu	Ioana	JMU	Teaching faculty	25%
Niculescu	Gabriel	JMU	Teaching faculty	25%
Gran	Rik	Duluth	Teaching faculty	75%
Lanari	Mark	Duluth	Masters Student	100%
Maher	Emily	MCLA	Teaching faculty	100%
Tagg	Nathaniel	Otterbein	Teaching faculty	70%
Brangham	Jack	Otterbein	Undergraduate Student	80%
Ransome	Ronald	Rutgers	Teaching faculty	90%
Kumbartzki	Gerfried	Rutgers	Scientist	10%
Tice	Brian	Rutgers	PhD Student	100%
Le	Trung	Rutgers	Postdoc	90%
Ray	Heather	Florida	Teaching faculty	90%
Osmanov	Bari	Florida	Postdoc	80%
Grange	Joe	Florida	PhD Student	30%
Mousseau	Joel	Florida	PhD Student	100%
Felix	Julian	Guanajuato	Scientist	90%
Zavala	Gerardo	Guanajuato	Scientist	80%
Urrutia	Zaida	Guanajuato	PhD Student	100%
Higuera	Aaron	Guanajuato	PhD Student	100%

Family Name(s)	Given Names(s)	Institution	Job Status	Research Fraction on MINERvA
Valencia	Edgar	Guanajuato	MS Student	100%
Zarazua	Cristina	Guanajuato	Undergraduate Student	100%
Juarez	Miguel	Guanajuato	Undergraduate Student	50%
Diaz	Roberto	Guanajuato	Undergraduate Student	80%
Velazquez	Isaac	Guanajuato	Undergraduate Student	80%
Kulagin	Sergey	INR	Scientist	25%
Butkevich	Anatoly	INR	Scientist	25%
Castromonte	César	CBPF	Posdoc	100%
Fiorentini	Arturo	CBPF	PhD Student	100%
Martines Caicedo	David	CBPF	Master Student	100%
da Motta	Hélio	CBPF	Scientist	70%
Palomino	José	CBPF	PhD Student	100%
Harris	Deborah	Fermilab	Scientist	95%
Morfin	Jorge	Fermilab	Scientist	75%
Osta	Jyotsna	Fermilab	PostDoc	100%
Schmitz	David	Fermilab	PostDoc	100%
Snider	Rick	Fermilab	Scientist	50%
Stefanski	Ray	Fermilab	Scientist	75%
Dytman	Steve	Pittsburgh	Teaching faculty	50%
Danko	Istvan	Pittsburgh	Postdoc	33%
Eberly	Brandon	Pittsburgh	PhD Student	100%
Naples	Donna	Pittsburgh	Teaching faculty	30%
Paolone	Vittorio	Pittsburgh	Teaching faculty	50%
Boyd	Steve	Pittsburgh	Teaching faculty	10%
Gallagher	Hugh	Tufts	Teaching faculty	50%
Kafka	Tomas	Tufts	Scientist	50%

Family Name(s)	Given Names(s)	Institution	Job Status	Research Fraction on MINERvA
Musial	Wojciech	Tufts	Undergraduate Student	100%
Oliver	William	Tufts	Teaching faculty	60%
Wielgus	Lauren	Tufts	Undergraduate Student	100%
Simon	Clifford	UC Irvine	PhD Student	100%
Ziemer	Benjamin	UC Irvine	PhD Student	100%
Kordosky	Michael	W&M	Teaching faculty	75%
Nelson	Jeffrey	W&M	Teaching faculty	67%
Devan	Josh	W&M	PhD Student	90%
Zhang	Dun	W&M	PhD Student	100%
Leo	Aliaga-Soplin	W&M	PhD Student	100%
Walding	Joe	W&M	Postdoc	50%
Kopp	Sacha	UT-Austin	Teaching faculty	80%
Jerkins	Melissa	UT-Austin	Postdoc	100%
Loiacono	Laura	UT-Austin	PhD Student	100%
Schellman	Heidi	Northwestern	Teaching faculty	50%
Fields	Laura	Northwestern	Postdoc	70%
Student	New	Northwestern	Masters Student	100%
Christy	Eric	Hampton	Teaching faculty	60%
Keppel	Cynthia	Hampton	Teaching faculty	35%
Zhu	Lingyan	Hampton	Postdoc	60%
Walton	Tammy	Hampton	PhD Student	100%
Ent	Rolf	Hampton	adjunct faculty / Jlab staff	20%
Monaghan	Peter	Hampton	Postdoc	25%
Afanasev	Andrei	Hampton	Teaching faculty	20%
Brooks	William	USM	Faculty	33%
Carquin	Edson	USM	Postdoc	50%
Contreras	Carlos	USM	Faculty	10%
Dvornikov	Maxim	USM	Postdoc	15%
Maggi	Giuliano	USM	Graduate student	60%
Peña	Cristian	USM	Pregraduate student	60%
Potashnikova	Irina	USM	Faculty	33%
Prokoshin	Fedor	USM	Scientist	33%
Gago	Alberto	PUCP	Teaching faculty	40%
Ochoa	Noemi	PUCP	Master Student	100%
Velasquez	Juan Pablo	PUCP	Master Student	100%

Family Name(s)	Given Names(s)	Institution	Job Status	Research Fraction on MINERvA
Alania	Marcos	UNI	Master Student	100%
Hurtado	Kenyi	UNI	Teaching faculty	50%
Pereyra	Orlando	UNI	Teaching faculty	20%
Solano	Carlos	UNI	Teaching faculty	70%
Tzanakos	George	Athens	Teaching faculty	30%

APPENDIX III. MINERvA Long-Term Testing Area Needs

MINERvA will need a long-term testing area (or areas) that can accommodate the following activities:

1. PMT Box Testing, Repair, and Assembly
2. PMT testing
3. Clear Fiber Cable Quality Control
4. Hot Spare DAQ Node Storage

This appendix describes the various environmental requirements specific to each activity, but all activities require an indoor space that is environmentally controlled. No crane coverage is needed.

1. PMT Box Testing, Repair and Assembly: currently this setup is in a room that measures 19½'x17' but could be in a somewhat smaller space. The devices that fall in this category are:

    a. PMT alignment stand—this device needs electrical power for the camera and the associated computing, and fits on a table that measures 3'x6'

    b. PMT Box Testing area: the DAQ for this test stand sits on one 3'x6' table, and an additional table nearby to hold the 4 PMT boxes is needed. Currently the table used for that is 2½ 'x6'. Both these tables need to be near outlets as well.

    c. PMT Box Assembly area: there are currently have 2 tables that measure 2½'x6' for this work but this could be downsized to one 2½'x6' table.

    d. PMT Box Storage area: this only requires a set of shelves that are at least 14" deep, and at least 24 linear feet of shelving that are 14" deep are needed.

2. PMT Testing: currently this setup is in a space that is about 5'x10'. The PMT test stand itself measures 28" x 31" x 69", and a height of about 80" to mount the tubes + electronics is needed.
   This space needs to be in a dark room (or covered with a lot of foil). There also needs to be space for a crate and a table to hold the data acquisition computer.

3. Clear Fiber Cable Quality Control: This setup currently measures 6½'x8', and storage for cables in this location also is also required. The shorter cables themselves are 1.1m, and 1.4m long so the boxes are somewhat longer than that. The longest cables require boxes that are closer to 1½m long.

4. Hot Spare DAQ Node Storage: there are some 1U and 3U servers that need a crate and a small table to hold a monitor, mouse, keyboard, and networking. In principle this isn't a lot of space (6'x3' table plus a rack would be plenty) but the servers themselves are extremely loud so these should not be stored in the same room where the other test stands are located. The experiment is currently using the 14th floor for a DAQ test stand area, and that would also need space for a rack and a 3'x6' table if that area needed to be vacated. The hot spare storage area is currently underground in the MINOS Near Detector hall.

APPENDIX IV. E-938 HAZARD IDENTIFICATION CHECKLIST

See next page for detailed descriptions of categories.

Flammable Gases or Liquids		**Other Gas Emissions**		**Hazardous Chemicals**		**Other Hazardous /Toxic Materials**
Type:		Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:		Flow rate:			Hydrofluoric Acid	
Capacity:		Capacity:			Methane	
Radioactive Sources		**Target Materials**			photographic developers	
	Permanent Installation		Beryllium (Be)		PolyChlorinatedBiphenyls	
	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:			Mercury (Hg)		TEA	
Strength:			Lead (Pb)		TMAE	
Lasers			Tungsten (W)		Other: Activated Water?	
	Permanent installation		Uranium (U)			
	Temporary installation		Other:	**Nuclear Materials**		
	Calibration	**Electrical Equipment**		Name:		
	Alignment		Cryo/Electrical devices	Weight:		
Type:			Capacitor Banks	**Mechanical Structures**		
Wattage:			High Voltage (50V)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
			Non-commercial/Non-PREP		Scaffolding/ Elevated Platforms	
			Modified Commercial/PREP		Other:	
Vacuum Vessels		**Pressure Vessels**		**Cryogenics**		
Inside Diameter:		Inside Diameter:			Beam line magnets	
Operating Pressure:		Operating Pressure:			Analysis magnets	
Window Material:		Window Material:			Target	
Window Thickness:		Window Thickness:			Bubble chamber	

OTHER GAS EMISSION

Greenhouse Gasses (Need to be tracked and reported to DOE)

- ❑ Carbon Dioxide, including CO_2 mixes such as Ar/CO_2
- ❑ Methane
- ❑ Nitrous Oxide
- ❑ Sulfur Hexafluoride
- ❑ Hydro fluorocarbons
- ❑ Per fluorocarbons
- ❑ Nitrogen Trifluoride

NUCLEAR MATERIALS

REPORTABLE ELEMENTS AND ISOTOPES / WEIGHT UNITS / ROUNDING

Name of Material	MT Code	Reporting Weight Unit Report to Nearest Whole Unit	Element Weight	Isotope Weight	Isotope Weight %
Depleted Uranium	10	Whole Kg	Total U	U-235	U-235
Enriched Uranium	20	Whole Gm	Total U	U-235	U-235
Plutonium-242[1]	40	Whole Gm	Total Pu	Pu-242	Pu-242
Americium-241[2]	44	Whole Gm	Total Am	Am-241	–
Americium-243[2]	45	Whole Gm	Total Am	Am-243	–
Curium	46	Whole Gm	Total Cm	Cm-246	–
Californium	48	Whole Microgram	–	Cf-252	–
Plutonium	50	Whole Gm	Total Pu	Pu-239+Pu-241	Pu-240
Enriched Lithium	60	Whole Kg	Total Li	Li-6	Li-6
Uranium-233	70	Whole Gm	Total U	U-233	U-232 (ppm)
Normal Uranium	81	Whole Kg	Total U	–	–
Neptunium-237	82	Whole Gm	Total Np	–	–
Plutonium-238[3]	83	Gm to tenth	Total Pu	Pu-238	Pu-238
Deuterium[4]	86	Kg to tenth	D_2O	D_2	
Tritium[5]	87	Gm to hundredth	Total H-3	–	–
Thorium	88	Whole Kg	Total Th	–	–
Uranium in Cascades[6]	89	Whole Gm	Total U	U-235	U-235

[1] Report as Pu-242 if the contained Pu-242 is 20 percent or greater of total plutonium by weight; otherwise, report as Pu 239-241.

[2] Americium and Neptunium-237 contained in plutonium as part of the natural in-growth process are not required to be accounted for or reported until separated from the plutonium.

[3] Report as Pu-238 if the contained Pu-238 is 10 percent or greater of total plutonium by weight; otherwise, report as plutonium Pu 239-241.

[4] For deuterium in the form of heavy water, both the element and isotope weight fields should be used; otherwise, report isotope weight only.

[5] Tritium contained in water (H2O or D2O) used as a moderator in a nuclear reactor is not an accountable material.

6 Uranium in cascades is treated as enriched uranium and should be reported as material type 89.

FERMILAB SIGNATURE PAGE

This page is not part of the TSW. It is used to ensure various Fermilab officers have read the document and have an opportunity to request changes, if needed.

___________________________ / / 2013
Jack Anderson, Chief Operating Officer
Interim Laboratory Director

___________________________ / / 2013
Greg Bock, Fermilab Assoc. Dir. for Research

___________________________ / / 2013
Stuart Henderson, Fermilab Assoc. Dir. For Accelerators

___________________________ / / 2013
Martha Michels, ESH&Q Acting Director

___________________________ / / 2013
Roger Dixon, FNAL AD Head

___________________________ / / 2013
Victoria White, Fermilab CS Head

___________________________ / / 2013
Mike Lindgren, FNAL PPD Head